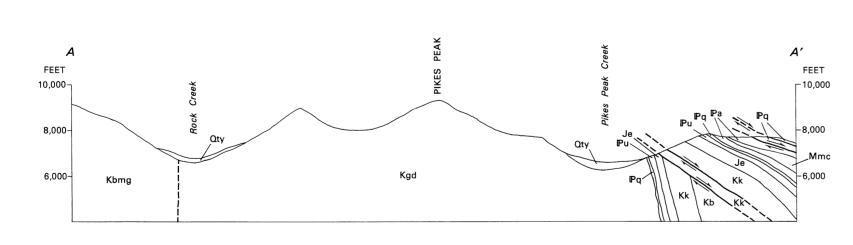


POWELL AND GRANITE COUNTIES, MONT.

Powell and Granite Counties, Mont.						
Area	Resource potential	Identified resources	Undiscovered resources	Deposit types		Favorable criteria
1	High	Gold, silver.	Gold, silver, molybdenum.	Vein, stockwork	2.	Occurrence of known deposits. Geochemical anomalies in resource elements Au, Ag, Mo, Cu, Pb, Zn, W, and in pathfinder elements Bi, Sb, As, Cd. Favorable geology consisting of veins along northwest- trending zone of fracturing in granodiorite. Alteration along veins and shear zones.
2	High	Molybdenum	Molybdenum, gold, silver.	Stockwork, vein	2.	Occurrence of known deposits. Geochemical anomalies in resource elements Au, Ag, Cu, Pb, Zn, Mo, W, and in pathfinder elements As, Sn, and Sb. Favorable geology consisting of veins in granodiorite and altered rock along veins.
3	Moderate	None	Molybdenum, gold, silver.	Stockwork, vein, placer.	2.	Occurrence of prospects. Geochemical anomalies in resource elements Ag, Cu, Pb, Zn, Mo, W, and in pathfinder elements Sn, Bi, Sb, Cd, Mn. Favorable geology consisting of (1) sparse veins and alteration in granodiorite, (2) surficial sediments in valleys that drain areas of gold-bearing veins.
4	Moderate	None	Tungsten, gold, silver, molybdenum.	Skarn, vein, placer, stockwork.		Geochemical anomalies in resource elements W, Au, Ag, Mo, Cu, Zn, and in pathfinder elements Mn, Be, Bi. Favorable geology consisting of (1) contact zone of granodiorite and Paleozoic carbonate rocks, and (2) presence of surficial deposits in valley that drains area of gold-bearing veins.
5	Low	None	Tungsten, gold, silver, molybdenum.	Skarn, vein, placer, stockwork.		Occurrence of prospects. Favorable geology consisting of (1) sparse veins in granodiorite, (2) contact zone of granodiorite and Paleozoic carbonate rocks, and (3) presence of surficial deposits in valley that drains area of gold-bearing veins.



MINERAL RESOURCE POTENTIAL AND GEOLOGIC MAP OF THE DOLUS LAKES ROADLESS AREA, POWELL AND GRANITE COUNTIES, MONTANA

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EXPLANATION

AREA OF MINERAL RESOURCE POTENTIAL Area of high potential

Area of moderate potential

Area of low potential

Commodities for which areas have potential are gold (Au), silver (Ag), molybdenum (Mo), and tungsten (W). Areas are described in table 1

MINES AND PROSPECTS 1. Mountain Top prospect Nellie prospect

· American Beauty prospec New York prospect BM-COR prospect 6. Hawkeye, Florence, and Josephine prospects Blue Streak No. 2 prospect

 Neversweat prospect 9. John G. Carlisle mine 10. Lost One (Clear Grit) prospect 11. Mudhole prospect 12. September Snow prospect

13. Snow Bunny (Majestic) prospect 14. Lancaster prospect 15. Comet prospect 16. Queen (Pikes Peak) prospect 17. Nugget prospect 18. Dewey prospect

19. Gilt Edge prospect 20. Amethyst prospect 21. Independence mine 22. Blue Diamond prospect 23. Bluebird Claim prospect 24. Edwin E. Graupner prospect

25. Big Bill prospect 26. Cosmopolitan prospect 27. Deceiver prospect 28. Dolo prospect 29. Cougar prospect 30. Schramm prospect

Mine having past production

Unconformity

Ygr

Yms

Υh

DESCRIPTION OF MAP UNITS

BIOTITE-MUSCOVITE MONZOGRANITE

YOUNGER GLACIAL TILL (PLEISTOCENE) --

Predominantly unweathered clasts of

deposits showing no preservation of

morainal topography. Sedimentary and

metasedimentary clasts dominant over

porphyritic, allotriomorphic granular,

muscovite. This pluton is cut by, and

medium to coarse grained; composed of

plagioclase (mostly oligoclase).

potassium feldspar (common as large

phenocrysts), quartz, biotite, and

probably genetically related to.

BIOTITE GRANODIORITE (CRETACEOUS)--Forms

Royal stock. Light-gray,

abundant pegmatite and aplite dikes

allotriomorphic- to hypidiomorphic-

composed of plagioclase (mostly

biotite, and minor amount of

muscovite. Near margin of the

granular, medium-grained granodiorite

andesine), potassium feldspar, quartz,

batholith, biotite content increases

and rock is gneissic, having foliation

parallel to contacts. Quartz veins,

many of which are mineralized, are

abundant in many parts of stock

BLACKLEAF FORMATION (CRETACEOUS) -- Black,

dark-gray, greenish-gray, grayish-

green, pale-green, pink, and buff

tuff. Shown in cross section but not

shale, sandstone, siltstone, and

exposed in roadless area. About

KOOTENAI FORMATION (CRETACEOUS) -- Reddish

and greenish siltstone, shale, and

sandstone; gastropod-rich limestone

near top and a less fossiliferous

limestone near base. About 900 ft

conglomerate, and minor limestone.

PHOSPHORIA FORMATION (PERMIAN) -- Interbedded

sandstone, shale, shaly limestone,

oolitic phosphorite, and phosphatic

QUADRANT FORMATION (PENNSYLVANIAN) -- Ridge-

forming, angular to subangular, well-

limestone. About 170 ft thick

sorted, medium- to fine-grained

silty mudstone and shale, and red

siltstone interbedded with sandstone

MISSION CANYON LIMESTONE (MISSISSIPPIAN) --

Richly fossiliferous, well-bedded

biosparite and biosparmicrite that

concretions. About 900 ft thick

cream-colored, fine-grained rock

imestone. About 900 ft thick

unit is green shale. About 15 ft

thick. Middle unit is grayish-blue

About 180 ft thick. Lower unit is

siltstone containing interbeds of

fine- to medium-grained quartzite

containing rounded to subrounded

grains. About 60 ft thick.

limestone containing lenticular ribbons

and pods of silty and sandy dolomite.

blackish-gray to olive-drab shale and

SILVER HILL FORMATION (CAMBRIAN) -- Upper

varying from dolomite to magnesium

and gray limestone. About 300 ft thick

quartzite. About 85 ft thick

AMSDEN FORMATION (PENNSYLVANIAN) -- Red

locally contains black chert

HASMARK FORMATION (CAMBRIAN) -- Gray to

ELLIS GROUP, UNDIVIDED (JURASSIC)--

About 300 ft thick

Calcareous shale and sandstone,

3.700 ft thick

highly weathered igneous clasts

(CRETACEOUS) -- Forms Mt. Powell

batholith. Very light gray,

granodiorite and granite in well-

CORRELATION OF MAP UNITS

> PROTEROZOIC Y

The Wilderness Act (Public Law 88-577, September Qty 3. 1964) and related acts require the U.S. Geological **QUATERNARY** Survey and the U.S. Bureau of Mines to survey certain Qto areas on Federal lands to determine their mineral Unconformity resource potential. Results must be made available to the public and be submitted to the President and the Kbmg Congress. This report presents the results of a Kgd mineral survey of the Dolus Lakes Roadless Area - CRETACEOUS (01429) in the Deerlodge National Forest, Powell and KЪ Granite Counties, Mont. The Dolus Lakes Roadless Area was classified as a further planning area during the Kk Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979. Unconformity JURASSIC Jе MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT Unconformity PERMIAN PuA mineral survey of the Dolus Lakes Roadless Area, an area of about 14 mi² in the Flint Creek Range Ρq of southwestern Montana, was conducted by the U. S. PENNSYLVANIAN Bureau of Mines in 1981 and by the U. S. Geological Pa Survey in 1980, 1981, and 1982. Results of this Unconformity survey indicate that the roadless area has significant mineral resource potential. Two subareas have high MISSISSIPPIAN Mmc potential for the occurrence of gold, silver, and Unconformity molybdenum resources. One subarea has moderate potential for the occurrence of resources of gold, €h silver, and molybdenum; one subarea has moderate potential for the occurrence of tungsten plus these €sh

> gold, silver, and molybdenum. One of the areas assigned high potential, the Pikes Peak-Rose Mountain area (area 1), has identified resources of about 57,000 tons containing gold and silver. The other area assigned high potential, the Tolean Lake-Game Pass area (area 2), has identified resources of 6 million tons of subeconomic molybdenumbearing rock that averages 0.036 percent molybdenum disulfide (MoS_2) .

same commodities; and the remainder of the roadless

GARNET RANGE FORMATION (PROTEROZOIC Y) --

to grayish green, micaceous, thinly

member is exposed in roadless area.

medium- to coarse-grained quartzite of

Middle member is a tan-weathering,

subarkose to arkose composition.

containing minor argillaceous and

Limestone, limy siltstone and shale,

or inferred; dotted where concealed

located or inferred; dotted where

located or inferred; dotted where

tentatively interpreted as thrust

limbs indicated by small arrows

STUDIES RELATED TO WILDERNESS

concealed. Sawteeth on upper plate

showing relative direction of movement;

concealed. Bar and ball on downthrown

and marble. About 5,000 ft thick

contact metamorphosed to calc-silicate

conglomeratic interbeds. About

HELENA FORMATION (PROTEROZOTC Y) --

CONTACT--Dashed where approximately located

NORMAL FAULT--Dashed where approximately

THRUST FAULT-Dashed where approximately

THRUST FAULT--In cross section only;

Inclined

1,600 ft thick

Silty argillite, argillaceous

bedded. About 1,200 ft thick

Types of deposits that are known or expected to occur in the roadless area are vein gold and silver, stockwork molybdenum, skarn tungsten, and placer gold. The roadless area has low potential for the occurrence of sand, gravel, stone, and phosphate resources. On the basis of the nature of the geologic preserved lateral and terminal moraines terrain, the potential for geothermal, coal, oil, or OLDER GLACIAL TILL (PLEISTOCENE)--Weathered gas resources is determined to be low.

INTRODUCTION

The Dolus Lakes Roadless area is in mountainous terrain of southwestern Montana, about 12 mi west of Deer Lodge and about 35 mi northwest of Butte (see index map). The area of about 14 mi² (about 9.000 acres) is part of the Deerlodge National Forest, Powell and Granite Counties. The roadless area forms the northeastern part of the Flint Creek Range and adjoins the Flint Creek Range Wilderness Study Area, separated from it by a narrow corridor along Rock Creek. The topography of the roadless area is dominated by a horseshoe-shaped mountain mass, open to to a regional thrust system called the Sapphire plate the east, that includes Pikes Peak, the highest point In the roadless area, with an elevation of 9.359 ft. (Ruppel and others, 1981). This system is Previous work in and adjacent to the Dolus Lakes Roadless Area includes geologic mapping and studies of mineral resources and various aspects of the geology y Emmons and Calkins (1913), Lyden (1948), Pardee (1951), Erickson and others (1981), and Mutch (1960). Reports by Allen (1966), Benoit (1974), and Baty (1976) discussed the structure, petrology, chemistry, and ages of intrusive rocks that are exposed over most of the roadless area. No new geophysical studies were conducted for this evaluation; however, results from other studies (Douglas, 1973; J. H. Hassemer, unpub. data) were utilized. Because the previous geologic mapping was inadequate for the purposes of this study, the entire area was remapped by the U.S. Geological Survey during 1980 and 1981. During 1981 and 1982 the U.S. Geological Survey conducted the geochemical survey. During 1981 the U.S. Bureau of Mines investigated mines and prospects in or adjacent to the roadless

GEOLOGY Middle rroterozoic rocks

The Helena, Mount Shields, and Garnet Range Formations, of the Belt Supergroup of Proterozoic age, crop out on the ridge southeast of the roadless area and along the south shore of Rock Creek Lake. The Mount Shields Formation is part of the Missoula Group, which overlies the Helena Formation. The Mount Shields Formation consists of three members. but only the middle member is present in the roadless

Paleozoic rocks

Rocks of Paleozoic age are exposed on Emery

Ridge, north of the roadless area, and along the east side of the roadless area from Pikes Peak Creek to Rock Creek Lake. Cambrian, Mississippian, and Pennsylvanian formations crop out in the roadless area, and rocks of Permian age crop out on Emery Ridge. Cambrian rocks include the Flathead Quartzite and Silver Hill Formation of Middle Cambrian age and the Hasmark Formation of Late Cambrian age. The Mission Canyon Limestone, part of the Madison Group, is Mississippian in age. Rocks of Pennsylvanian age include the Amsden and Quadrant Formations, and the Phosphoria Formation, exposed on Emery Ridge, is

The Phosphoria Formation is economically important in the region because it contains bedded phosphorite. Major amounts of phosphatic rock have been mined from the Phosphoria in the Douglas Creek mining district, about 6 mi northwest of the Dolus Lakes Roadless Area, and from the Garrison mining district, about 12 mi to the northeast. The FLATHEAD QUARTZITE (CAMBRIAN)--Well-sorted, Phosphoria Formation is not exposed in the roadless area but is exposed on Emery Ridge north of the roadless area.

Mesozoic sedimentary rocks

siltstone, and silty sandstone; green The only Mesozoic sedimentary rocks that crop out in the roadless area are exposed in the northeastern part and are correlated with the Ellis Group of Jurassic age. However, rocks belonging to this group MOUNT SHIELDS FORMATION (PROTEROZOIC Y)-and to the Kootenai Formation of Cretaceous age are Composed of three members; only middle exposed over much of Emery Ridge. The Ellis Group is separated from the underlying Phosphoria by a regional chromium, lanthanum, nickel, tin, and vanadium. The unconformity.

> Cretaceous intrusive rocks The Royal stock, exposed over most of the study

area, extends to the west and southwest, covering a total area of about 30 mi². It was described as a biotite granite by Emmons and Calkins (1913). In the IUGS system (Streckeisen, 1975), used in this report. the modal composition of this unit is predominantly granodiorite. The Royal stock has an indicated fission-track age of 67 m.y. (Baty, 1976), and work in progress by the potassium-argon method confirms a Late Cretaceous age (J. D. Obradovich, unpub. data). Abundant quartz veins in the Royal stock represent barren quartz, quartz-limonite, and quartz-sulfide types. The quartz veins have been emplaced along joints and shear zones; they generally are in the range of 0.5 in. to 1 ft in thickness and rarely are 1-3 ft thick. These veins are most abundant in two areas: (1) the area between Tolean Lake and Game Pass, where a stockwork of closely spaced veins is found; and (2) a zone of northwesterly trending, parallel veins extending from Pikes Peak to Rose Mountain: these are spaced tens to hundreds of feet apart. Elsewhere in the roadless area, veins are common but more widely spaced. Rocks of the Mount Powell batholith are exposed

faults having east dip and west-to-east south of the roadless area on the upper slopes of the displacement, based on regional valley of Rock Creek. This batholith occupies an area structural and stratigraphic relations of slightly more than 50 mi² across much of the eastcentral and southeastern parts of the Flint Creek STRIKE AND DIP OF BEDS The batholith is accompanied by abundant

pegmatite and aplite dikes, many of which contain muscovite and garnet in addition to quartz and feldspar. Quartz veins are rare in the Mount Powell batholith. OVERTURNED ANTICLINE--Direction of dip of

Field relations indicate that the Mount Powell batholith is younger than the Royal stock and intrudes it. Chemical analyses of whole-rock samples of the two plutons show each to be internally quite homogeneous and chemically distinct from the other. but a few samples taken from near the contact of the two plutons suggest a gradational relationship (Benoit, 1974). This and other chemical and mineralogical evidence suggests that the Mount Powell is a later, more silicic and felsic differentiate of the same magma that produced the Royal stock (Benoit,

Ouaternary deposits

Deposits of Quaternary age, predominantly glacial till, are widespread in the roadless and surrounding areas, occupying stream valleys that drain the area and mantling terraces that border the east side of the roadless area. Most of these deposits are of glacial origin, but they include minor alluvial deposits formed along the present streams since glaciation. Two ages of glacial deposits are recognized and differentiated by geomorphic form, the relative proportions of sedimentary to igneous clasts, and the degree of weathering of the igneous clasts. The early glacial till has been mapped along the steep eastern side of the roadless area and on terraces east. northeast, and southeast of the roadless area: no morainal topography is preserved in these deposits. In this older till, clasts of sedimentary rocks predominate over those of igneous rocks, and the latter are highly weathered. The late glacial till forms well preserved lateral and terminal moraines, mainly along stream valleys. In this till, clasts of igneous rocks, which are predominantly unweathered, are much more abundant than clasts of sedimentary

important because in the Pioneer district to the related to the earliest glacial stage. Pardee (1951) distinguished three stages of glaciation, all of which had a source in the vicinity of the roadless area. The earliest stage was responsible for most of the gold that was transported by glaciers to the vicinity of the Pioneer district. This gold probably came from Union Carbide Corp. has identified about 1 million veins in sedimentary rocks in the roof zone of the Royal stock, which were stripped off by the glaciers. In two later stages of glaciation, an intermediate till containing moderate amounts of gold and a late till containing relatively little gold were the Flint Creek Range Wilderness Study Area; and (2) deposited. The intermediate stage of glacial till was the existence of about 25 million tons of paramarginal not recognized in the roadless or surrounding areas, but if present it is probably included in what was mapped as early till. According to Pardee (1951), this intermediate till is distinguished by a preponderance of metasedimentary rocks.

Sedimentary rocks of the roadless and surrounding areas are strongly deformed by folding and faulting. Structures are best seen on Emery Ridge, to the north where several thrust faults, a normal fault, and recumbent folds occur in the Paleozoic and Mesozoic units. Thrust faults have also been mapped in the eastern part of the roadless area and southeast of it. In the northeastern part of the roadless area, a normal fault juxtaposes Jurassic and Mississippian Structures seen in the sedimentary section belong

characterized by structures of several types: anastomosing imbricate thrust faults; numerous younger-over-older thrusts; mixed steep and flat, west-dipping thrusts and some east-dipping thrusts: isoclinal, overturned folds; and breccia along sole zones of thrust faults. Based on radiometric and stratigraphic evidence, the age of thrusting is Late Cretaceous. East transport of at least 70 km is suggested for the western part of the Sapphire plate (Ruppel and others, 1981). The Royal stock was emplaced in the sedimentary section near the end of the Cretaceous Period after active thrusting had ceased. Evidence that emplacement was post-tectonic is the general lack of structure in the granodiorite stock and the truncation by the stock of thrust and normal faults in the sedimentary rocks. Structural and petrologic features are consistent with forceful intrusion of the stock (Allen, 1966). A prominent set of primary joints strikes about N. 65° W. and dips 55° SW. (Allen, 1966). Aplite dikes and quartz veins, many of which were mineralized, parallel this joint set. A zone in the granodiorite of crushing and shearing accompanied by intense foliation of unknown extent and origin trends north-northeast through an exposure on Rock

Creek (Emmons and Calkins, 1913).

Evaluation of the mineral resource potential of the roadless area is partly based on 180 geochemical samples. These samples consisted of 35 panned concentrates of stream sediments, 35 fine-grained stream-sediment samples, 22 soil samples, and 88 rock samples. All the samples were analyzed by a six-step, semiquantitative emission-spectrographic procedure for 31 elements. Selected samples were analyzed by wetchemical methods for copper, lead, zinc, tungsten, cadmium, bismuth, antimony, arsenic, gold, and mercury. The geochemical data and pertinent geological parameters were stored on magnetic disc in the U.S. Geological Survey's computer in Denver,

Colo. Geochemical data applicable to mineral resource potential are presented here. In panned concentrates, anomalies were found for gold, silver, copper, lead, zinc, bismuth, molybdenum, tungsten, boron, beryllium, cobalt, nickel, and vanadium. The most notable anomalies, particularly

for tungsten, lead, copper, and bismuth, were in samples from along Rock Creek; and for silver, copper ead, zinc, bismuth, and boron in samples from sec. 2 T. 8 N., R. 12 W. Gold anomalies were also present in samples from sec. 24, T. 8 N., R. 12 W., from streams near Doney Lake, and from along Pikes Peak Creek. In stream-sediment and soil samples, anomalies were found for silver, copper, lead, zinc, molybdenum, tungsten, boron, beryllium, manganese, cadmium, and bismuth. Stream-sediment samples from the Dolus Creek drainage basin were anomalous in silver, copper, lead, and zinc. Samples from the Rock Creek drainage basin were anomalous in many elements, including silver, copper, lead, zinc, molybdenum, tungsten, beryllium, boron, with a quartz-pyrite stockwork with a quartz-pyri

and manganese. Soil samples taken along the ridge in secs. 23, 24, 27, and 34, T. 8 N., R. 12 W., were anomalous in silver, copper, lead, molybdenum, zinc and other elements. Geochemical anomalies in rock samples were found at many localities for one or more of the following elements: gold, silver, copper, lead, zinc, arsenic, cadmium, bismuth, antimony, molybdenum, tungsten, manganese, boron, beryllium, most abundant anomalies are for the base and precious metals, as shown not only by spectrographic analyses but also by wet-chemical analyses. Nearly all the surround most veins. rock samples were anomalous in one or more elements. The Queen (Pikes Peak) prospect contains The strongest anomalies were in samples from along Pikes Peak ridge in secs. 20, 29, and 30; T. 8 N., R. 11 W., and the ridge in secs. 23, 26, 27, and 34, T. 8 N., R. 12 W. Most of the anomalies were in samples from the Royal stock or in contact zones of

lanthanum, nickel, tin, and vanadium commonly were associated with anomalous concentrations of molybdenum, tungsten, or of precious metals or base Correlation analyses (VanTrump and Miesch, 1977) were done on the analytical data to determine geochemical associations that might be related to mineralizing processes. In panned-concentrate samples, correlation coefficients that imply a positive mutual correlation at a confidence level of 95 percent or greater were obtained for silver, zinc, lead, copper, and boron. In stream-sediment and soil samples, similar correlations at the 95-percent confidence level were evident for silver, copper, and lead. In rock samples, strong positive correlations were noted for two groups of elements; these are (1)

silver, gold, arsenic, cadmium, copper, lead,

lanthanum, scandium, vanadium, and yttrium.

the stock with sedimentary rocks. Anomalies of

concentrations of boron, beryllium, chromium,

molybdenum and tungsten were found in samples from

several localities, but anomalies of both metals in

samples from the same sites were uncommon. Anomalous

GEOPHYSICS

antimony, and zinc, and (2) calcium, boron, chromium,

Previous and current regional studies of gravity and magnetics were reviewed to ascertain their applicability to the mineral resource assessment. The roadless area has been covered by a regional gravity survey in progress for the Butte 10x20 quadrangle (Hassemer and Hanna, 1982). Because of the wide spacing of the gravity stations relative to the size of the roadless area, the Bouguer anomaly man of the roadless area is relatively featureless. The map shows that the Royal stock coincides with a weak negative gravity anomaly. The roadless area is also within that of a regional aeromagnetic survey (Douglas, 1973), but the results can be used only to discriminate large features such as the Royal stock. which coincides with a strong, circular positive

MINING DISTRICTS AND MINERALIZED AREAS

History and geologic setting of deposits The Dolus Lakes Roadless Area is in one of the

richest mineral-producing regions of Montana. Since the discovery of gold in Gold Creek in 1852, the first reported from Montana, mining production from 15 districts in the Flint Creek Range has had an estimated aggregate value of \$120 million (actual value at time of production; compiled from USGS Mineral Resource Data System (MRDS) records). Philipsburg is the most important of these districts, having a production of about \$100 million (compiled from MRDS records), principally of silver and manganese, and lesser amounts of zinc, lead, gold, and copper. Other important districts in the Flint Creek Range are the Pioneer district, having a production of about \$7 million in gold from placer deposits (Lyden, 1948); the Dunkleberg district, having about \$1.9 million production (compiled from MRDS records), mainly of lead and silver; and the Princeton (Boulder Creek) district, having a production of about \$1.6 The distinction in the age of glacial deposits is million (compiled from MRDS records) of mainly gold, silver, and lead. In addition, the Douglas Creek Gird Creek) district has produced a significant amount of phosphate.

Identified resources of tungsten and phosphate have been reported for other parts of the Flint Creek Range (Erickson and others, 1981), southwest of the Dolus Lakes Roadless Area: (1) mineral exploration by tons of tungsten resources averaging more than 0.6percent WO₂ in skarn along the contact of the Royal stock near the head of Boulder Creek, and additional tungsten resources may also occur in other parts of resources of phosphate rock was estimated on the basis of results of exploration by Cominco American, Inc. In addition, mineral exploration by Noranda Exploration, Inc., has delineated a molybdenum-bearing stockwork zone in the vicinity of East Goat Mountain (Erickson and others, 1981).

Mineral deposits exploited in the past include placer gold: vein silver and gold (zinc and lead in places); replacement silver, zinc, and lead; replacement manganese; and stratabound phosphate deposits. In addition, contact-metasomatic tungster and stockwork molybdenum deposits are known to exist in the Flint Creek Range (Ericksen and others, 1981). Most deposits are found near or at contacts of intrusive rocks, such as granodiorite, with sedimentary rocks, especially carbonates such as

limestone and dolomite. The Pioneer district adjoins the roadless area on the northeast and includes the lower parts of Gold Creek, Pioneer Gulch, and Pikes Peak Creek (see index map). Mining of placer-gold deposits began in this district in 1862 and continued sporadically until about 1941, when dredge mining of Pioneer Gulch was suspended. The district produced an estimated \$7 million in gold. Presumably, most of the gold had its origin in vein deposits in sedimentary rocks in the roof zone of the Royal stock. These gold-bearing veins were stripped off, and the gold was deposited in glacial till in the area of the Pioneer district. outwash streams and subsequent interglacial and postglacial streams reworked the till deposits. concentrating the gold in terrace and stream gravels

(Pardee, 1951) The Rose Mountain (Gold Creek) district overlaps the roadless area on the north (see index map). Most of the mines and prospects examined during this study are in this district. The district has produced about \$100,000 in minerals, about half of which was in gold from placers in the upper sections of Gold Creek. The remainder was from lode deposits, principally narrow, gold- and silver-bearing fissure quartz veins in granodiorite. Two mines adjacent to the roadless area, the John G. Carlisle and Independence mines (sites 9 and 21), had minor production totaling about \$12,500, mostly in gold and silver.

Examination of prospects

Mining-claim records on file in Granite and Powell Counties indicate that 515 claims have been located in or adjacent to the roadless area: records of active claims on file in 1981 with the U. S. Bureau of Land Management totaled 74 lode claims and 7 placer claims. Thirty mines and prospects were examined and sampled during fieldwork in the area: 329 samples were collected and analyzed. No mines in the roadless area were active in 1981. The classification of resources for mines and

prospects in the roadless area follows the guidelines in U. S. Geological Survey "Circular 831" (U. S. Bureau of Mines and U. S. Geological Survey, 1980). Three properties within the roadless area and one adjacent to the northern boundary have indicated or inferred gold, silver, and molybdenum resources. The most significant deposits are the BM-COR prospect (site 5), the Independence mine (site 21), the Queen (Pikes Peak) prospect (site 16), the Snow Bunny (Majestic) prospect (site 13), and the John G. Carlisle mine (site 9).

The BM-COR prospect, held by Houston International Minerals Corp. in 1981, contains 6 million tons of indicated subeconomic molybdenum resources averaging 0.036 percent molybdenum disulfide (MoS₂). Amax Exploration, Inc., located a series of claims here in 1975 and drilled three test holes in 1976, which intersected molybdenum-bearing quartz-pyrite veins. A new block of claims was located in this area in 1979-1980 by Houston International Minerals Corp. in response to favorable geochemical data that they had collected. The molybdenum-bearing zone is associated with a quartz-pyrite stockwork within the biotite

roadless area, contains 8,100 tons of indicated and per ton and 0.60 oz silver per ton. U.S. Bureau of Mines records show that between 1926 and 1935, 481 oz of gold, 197 oz of silver, and 189 1b of copper were produced from this mine. Marginal reserves of gold and silver are in a quartz vein averaging 0.8 ft thick shear zone in granodiorite. Boxwork limonite is associated with the vein, and sericitized halos

8.000 tons of marginal reserves in quartz veins that average 0.09 oz gold per ton and 9.4 oz silver per ton. An adit 190 ft long follows quartz veins that trend N. $30^{\circ}-80^{\circ}$ W. and dip $60^{\circ}-80^{\circ}$ SW. along a shear zone in granodiorite. Veins of various widths are exposed for 170 ft in the adit, and the mineralized zone has an average thickness of 3.3 ft. The Snow Bunny (Majestic) prospect contains 49,000 tons of inferred marginal reserves in quartz veins that average 0.09 oz gold per ton and 0.25 oz

silver per ton. Workings include a partially caved adit open for 27 ft from the portal, four caved shafts having depths from 6 to 12 ft, and numerous pits and trenches. The mineralized and altered shear zone was traced for 1,100 ft in a northwesterly direction. The richest segment is 750 ft long and averages 2.1 ft The John G. Carlisle mine, about 1,000 ft outside the roadless area, is on a group of four claims that were patented in 1902. Between 1897 and 1899, about

120 oz of gold and some silver was recovered from ore mined from the main workings. A 600-ft-long adit followed quartz veins that trend N. 50° W. and dip 75° SW. in a shear zone in granodiorite (Emmons and Calkins, 1913). The zone is as wide as 10 ft. In 1981, five caved adits, one 20-ft-long trench, and a small pit were on the claims. The mine has been inactive for about 40 years.

The deposits at the Queen and Snow Bunny prospects and the John G. Carlisle mine appear to occur along the same shear zone, but the valley between the Queen and Snow Bunny prospects contains glacial till that prevents verification of the

ASSESSMENT OF MINERAL RESOURCE POTENTIAL.

Commodities

The assessment of mineral resource potential of

the roadless area is focused principally on several commodities that are found there. These are gold, silver, molybdenum, tungsten, copper, lead, and zinc. Anomalously high concentrations of these elements occur in stream-sediment, panned-concentrate, and rock samples collected during the geochemical survey and in samples from mines and prospects. The roadless area probably does not have potential for resources of manganese, bismuth, arsenic, antimony, beryllium, and cadmium, although such elements were present in anomalous amounts in many samples. However, the distribution and levels of concentration of these elements are important because these elements commonly are parts of element suites that are characteristic of certain hydrothermal deposit types in the roadless area. They are regarded as pathfinder elements because they are associated with, or are dispersed around, deposits of commodity elements such as gold, silver, molybdenum, tungsten, copper, lead, and zinc.

Other commodities in the roadless area are dolomite and limestone for cement, granodiorite for building stone, and sand and gravel for aggregate. Such materials, however, are more readily available elsewhere in more accessible locations and closer to markets. Phosphate leases extend a short distance into the roadless area, but, although phosphate rock occurs on Emery Ridge north of the roadless area, none was found within it. Oil and gas lease applications have been made for most of the roadless area, but the potential for occurrence of oil or gas resources in the area is low. Plutonic igneous rocks are exposed over most of the roadless area, and the surrounding sedimentary rocks have been heated to such high temperatures that any oil or gas generated would have been destroyed or driven to cooler parts of the sedimentary section. No coal or geothermal energy resources are known.

Potential for mineral resources

The potential of various parts of the roadless area for resources is rated as high, moderate, or low on the basis of the degree to which favorable criteria are met. Resources are classed either as identified, as determined in the examination of mines and prospects, or as undiscovered, on the basis of the interpretation of geological, mines and prospects, drilling, and geochemical data and observations. The deposit types that are listed for each area are based on known deposits in the roadless area or on oredeposit models, defined by known occurrences, that fit the geologic, geochemical, and geophysical characteristics of each area. The favorable criteria used in this rating include:

(1) The occurrence of mines and prospects: the kinds of deposits and the abundance of prospects. (2) The occurrence of geochemical anomalies: the specific elements and their concentration ranges, the kinds of media sampled, the number of anomalous samples, and the consideration of suites of anomalous elements as representatives of particular types of

(3) Favorable geology: the presence of favorable host rocks and favorable structural setting, and the presence of igneous rocks or degree of proximity to igneous rocks that could have been heat or metal sources or could have been hosts to deposits. The roadless area contains two subareas having

high potential for resources and two subareas having moderate potential; the remainder of the roadless area has low potential. The resulting interpretation of the mineral resource potential is shown in table 1 and on the map. Undiscovered resources are expected to occur as stockwork (or porphyry), vein, skarn, and placer deposits. Area l is a zone trending northwest from the

vicinity of Pikes Peak to Rose Mountain. It includes five prospects in the roadless area and one mine and two prospects outside but near the northern border. Two prospects in the roadless area, the Snow Bunny and Queen, have identified resources of gold and silver. The known deposits are small and occur as northwesttrending, narrow quartz veins and mineralized shear zones that parallel the principal attitude of joints and minor faults in the granodiorite stock. Rock samples of many small, mineralized quartz veins and fractures in granodiorite were analyzed and found to contain anomalously high concentrations of gold, silver, copper, lead, zinc, arsenic, antimony, bismuth. and cadmium: these concentrations indicate high potential for the occurrence of gold and silver resources in additional vein deposits. Several of these rock samples also were anomalous in molybdenum this characteristic indicates a low potential for the occurrence of stockwork molybdenum resources at depth in the roadless area. Area 2, the Tolean Lake-Game Pass area, includes

the BM-COR prospect, having identified resources of molybdenum; three other prospects in the roadless area; and one prospect outside but near the boundary. Rock samples from area 2 are anomalous in gold, silver, molybdenum, tungsten, copper, lead, zinc, arsenic, tin, and antimony. Elements that were present in anomalously high concentrations in streamsediment and soil samples from area 2 are silver, molvbdenum. zinc. lead. and copper. Pannedconcentrate samples were anomalous in molybdenum tungsten, and zinc. This geochemical evidence and the occurrence in drill holes and prospect workings of mineralized veins having altered envelopes indicate a high potential for the occurrence of molybdenum resources in stockwork deposits and gold and silver resources in vein deposits. Area 3 covers much of the roadless area; it contains, within the roadless area, nine prospects and one mine having identified resources and also four prospects outside, but adjacent to, the northern

boundary. Area 3 is underlain entirely by granodiorite, and known deposits are much like those in area 1, mostly mineralized veins and shear zones in granodiorite. Small quartz veins, commonly about 1-6 in. wide, are numerous in exposures along ridge tops; these veins strike mostly northwesterly and dir to the southwest. Rock samples, principally from these veins, contained anomalously high concentrations of silver, molybdenum, copper, zinc, lead, tungsten, imony, tin, bismuth, and cadmium. Sediment sample from streams draining this area were anomalously high

MISCELLANEOUS FIELD STUDIES

MAP MF-1640-A

PAMPHLET ACCOMPANIES MAP The Independence mine, about 1,500 ft outside the in silver, copper, lead, zinc, cadmium, molybdenum, tungsten, manganese, and bismuth. Panned-concentrate inferred marginal reserves, which average 0.44 oz gold samples were found to be anomalous in molybdenum, tungsten, silver, zinc, and bismuth. Compared to areas 1 and 2, however, the values of these elements

are generally lower, the veins are narrower and fewer and alteration is less evident. Area 3 has moderate notential for the occurrence of molybdenum resources Area 3 also includes surficial glacial and

that trends N. $50^{\circ}-70^{\circ}$ W. and dips $55^{\circ}-70^{\circ}$ SW. along a in stockwork deposits and gold and silver in vein alluvial deposits along Rock, Dolus, and Pikes Peak Creeks. Because of the occurrence of gold-bearing veins in areas that these streams drain, area 3 has

moderate potential for the occurrence of gold resources in placer deposits. Although much of area 4 is covered by surficial

deposits, favorable geology consisting of a contact zone between granodiorite and Paleozoic carbonate rocks is inferred. Such a contact zone is especially favorable when the intrusive rock projects into the sedimentary rocks and when the sedimentary rocks are carbonate rocks that are highly fractured due to folding and faulting. These conditions are inferred to exist in area 4. The contact zone here may be similar to that at Finley Basin, about 4 mi southwest of the roadless area, where skarn tungsten deposits o possible ore grade occur in the contact zone between the Royal stock and Paleozoic carbonate rocks (Ericksen and others, 1981). Evidence of mineralization in area 4 comes from a rock sample collected from near Rock Creek Lake that contained

anomalously high concentrations of a suite of elements consistent with the occurrence of skarn tungsten deposits, including tungsten, molybdenum, gold, copper, manganese, and beryllium. Stream-sediment samples from this area contained anomalous amounts of zinc and silver, and one panned concentrate was anomalous in molybdenum, tungsten, and zinc. Like area 3, this area has surficial deposits that may contain placer-gold deposits. Area 4, located along lower Dolus Creek, has moderate potential for the occurrence of resources in skarn tungsten, vein gold and silver, placer gold, and stockwork molybdenum deposits. Area 5, the northeastern part of the roadless

area, has three prospects but no geochemical anomalies. Favorable geology consists of the occurrence of sparse veins in granodiorite and in the contact zone between granodiorite and Paleozoic and Mesozoic sedimentary rocks, much of which is limestone. The area also includes surficial deposits that may contain placer-gold deposits. Area 5 has low potential for the occurrence of resources in skarn tungsten, vein gold and silver, and stockwork molybdenum deposits.

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